Saskatchewan Agriculture and Food

Wheat Stem Sawfly

November 2005

Introduction

The wheat stem sawfly (Fig. 1) is thought to be native to North America and is found throughout the brown soil zone of the Great Plains. First noticed in Canada in the late 1800s, the wheat stem sawfly was considered an agricultural pest by the early 20th century. Spring wheat is the preferred host for this insect, however, recent reports from Alberta and especially Montana indicate that some varieties of winter wheat are also suitable hosts for this pest.

Figure 1. Female wheat stem sawfly. T. Shanower, USDA-ARS, Sidney, MT.

A survey of WSSF infestations was conducted in 2003.

Many producers consider the wheat stem sawfly to be a problem only in field margins. Although crop injury by the wheat stem sawfly is usually more prevalent within the first 20 metres of the field edges, damage is not confined to the margins. In many of the recent sawfly infestations, entire fields have been affected, some with estimates of more than 70 per cent of the stems cut.

The survey included both margins and interiors of fields. Results were mapped on a regional basis and can be viewed in the Wheat Stem Sawfly Survey Map document.

Figure 2. Sawfly damage

Figure 3. Distribution of wheat stem sawfly in the northern plains.

Economic loss due to the wheat stem sawfly may be a reduction in yield and/or grade as a result of larval feeding within the stem. Estimates suggest a five to 15 per cent decrease in total seed

weight. The biggest loss, however, is from the stems being cut and plants falling to the ground, making pick-up for harvest extremely difficult.

The wheat stem sawfly had not been a significant pest for a number of years. Dry weather cycles and tight wheat rotations are the primary factors contributing to increased sawfly populations. Warm, sunny, calm weather following spring rains will result in wider dispersal of the insect within a field or to adjacent fields. Excessively wet conditions tend to be detrimental to both sawfly and parasite populations and activity. In the absence of severe sawfly pressure, producers tended to choose wheat varieties that offered attributes such as increased yield, protein and disease resistance rather than sawfly resistance. To some degree, the adoption of conservation tillage practices that leave stubble containing sawfly larvae intact may also favour increased wheat stem sawfly populations.

Description, Life Cycle and Economic Significance

The name "sawfly" is misleading, as it is not a true "fly." The wheat stem sawfly (*Cephus cinctus* Norton) is a member of the order Hymenoptera, family Cephidae. Other insects in this order include wasps, bees and ants.

Sawflies lack the conspicuous constriction between thorax and abdomen that is characteristic of most other members of this family. As with other insects in this order, the sawfly has two pairs of wings, unlike flies (Order Diptera) that have only one pair of membranous wings. The name sawfly is used because of the saw-like ovipositor (organ) used by the female sawflies to cut into the plant tissue to lay eggs.

An adult sawfly is shiny black with three yellow bands around the abdomen. The legs are yellow. The wings are "smoky" tinted. Adults are approximately eight to 13 millimetres (mm) (5/16 -1/2 Inch) in length and are characteristically inactive, often seen resting on wheat stems with their head directed downward (Fig. 1).

The adults emerge in June and are usually present in wheat fields until mid-July. Although the adult female lays eggs in the plant stem, she does not feed on the plant. The primary purpose of the adult is reproduction. A healthy adult female may lay up to 50 eggs, usually only one egg per stem. Other females may lay eggs in the same stem, but only one larva will survive per plant. The first egg to hatch is cannibalistic on any other eggs present in the same stem.

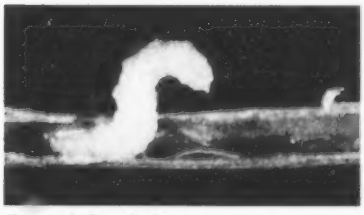

Figure 4. Saw fly larvae
G. Evjen Photographer (retired) SPARC, AAFC, Swift Current

Eggs are approximately one mm long, milky white and crescent-shaped. They take about five to eight days to hatch. Larvae are cream coloured, wrinkled and are more strongly S-shaped (Fig. 4) than other stem-boring insect larvae (e.g. wheat stem maggot) when removed from the stem. They have a brown head and a short blunt projection on the rear end. At maturity, the larvae can reach a length of about 13 mm (1/2 in).

Within the stem, the larvae feed upward, boring through the nodes for a month or longer. As the plant starts to senesce (ripen), allowing sunlight to filter through the stem, the larvae respond by moving toward the bottom of the stem and turn around. With head now upwards, the larvae cut a groove around the entire inside of the stem generally less than 25 mm (one inch) above the ground. Moisture content of the plant appears to be a cue at this point since it appears that the larva will not cut a stem unless moisture content is below 50 per cent.

The cut weakens the stem so it falls over easily making it difficult to harvest, resulting in yield loss. Heavy winds, rain and other factors contribute to increased lodging that can be even more apparent in thin stands. Attempts to harvest the fallen plants often result in considerable equipment damage and increased fuel costs.

In recent yield trials, the average yield losses (grain from heads not harvested) for the hollow-stemmed varieties were 13 per cent with a range of 7.3-22.5 per cent, or $10.75/ha ($4.30/acre). Losses in yield were compounded by additional operating costs (harvesting in one direction) resulting in an average loss of $10/acre. A swathing operation may reduce grain losses, but operational costs would increase by $7/acre. The average crop value during the study was $41.50/acre, and average yield was only 14 bushels per acre. The average crop value for the newest solid stemmed cultivar, AC Abbey, was $51.60 per acre.

Figure 5. Larvae in a cut stem Semiarid Prairie Agricultural Research Centre, Swift Current

Sawfly feeding on the inside of the stem also damages the phloem tissue, affecting the transfer of nutrients to the head. This results in an overall reduction in the number of seeds per head and a corresponding yield decrease ranging from five to 15 per cent. In addition, the filling of seeds will be affected, resulting in shriveled seeds that lower the test weight and may cause the grain to be downgraded. If the kernels appear shriveled or distorted as a result of sawfly feeding, the Canadian Grain Commission limits damage to No. 1 CWRS, No. 2 and No. 3 to two per cent, five per cent and 10 per cent respectively.

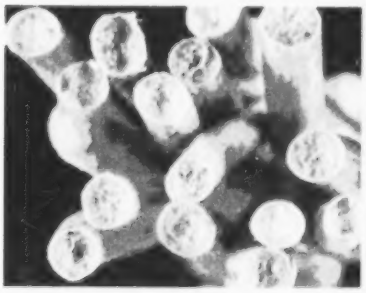

Figure 6. Stem plugged with frass (larval feces) and plant material. B. Beres, Lethbridge Research Centre, AAFC

In preparation for over-wintering in the stubble, the larvae plug the stem with frass (larval feces) and plant material (Fig. 6). The larvae produce a long, thin, brown transparent cocoon below the cut in the stem. In laboratory tests, sawfly larvae did not survive temperatures below minus 22 degrees C, but larvae are more buffered from temperature extremes in their location at or below the soil surface. Pupae will not be formed until the following May.

There is only one generation per year. However, there is evidence that very high springtime temperatures may induce the larvae back into a resting stage and the generation may take two years to complete.

After completing development and escaping from the pupa, adults chew and push through the plugged stem, emerging from mid-June to early July. The males emerge first, with female emergence commencing a few days later. They tend to remain near the area where they emerge because they are weak fliers. If cool, wet weather occurs during emergence, the period of emergence is extended. Wet conditions also assist in softening the plug in the stem allowing for easier emergence of the adult sawfly.

Host Plants and Susceptible Stage

The primary hosts for the wheat stem sawfly are cultivated cereal crops. The most preferred hosts are spring and durum wheat, although rye, triticale and even barley can be affected. In Montana, winter wheat, the most common wheat class, is severely affected. Winter wheat is not normally the preferred host in Canada, but there have been cases where it has been infested as severely as spring wheat. Natural, indigenous hosts include some native grass species (mostly

wheatgrasses – genus *Agropyron*), generally with larger stems. Prior to stem elongation, the wheat plants are not attractive for egg laying.

Figure 7.Larvae in stem
B. Beres, Lethbridge Research Centre, AAFC

Scouting and Risk Threshold

Female sawflies can be distinguished from males by the presence of a distinct ovipositor for egg laying, at the posterior end of the abdomen.

Adults will typically emerge in late-June and the first week of July. A sweep net can be used to sample for adult sawflies. An average of two females for every 10 sweeps corresponds to about 12 per cent stems cut in the sample area. Four sawflies in 10 sweeps results in about 23 per cent cut stems. Pesticide application is not recommended, even if a high number of adults are observed in the field, as there is no guarantee that egg deposition has not already occurred.

Monitor the field again in late-July. While the crop is still green, infested stems may appear with regions of mottled discolouration. Split the stems lengthwise to determine if a sawfly larva is present and feeding on the stem (Fig. 7). This will provide some insight with respect to sawfly damage in the field prior to crop maturity.

Control and Management

There are no established economic thresholds for wheat stem sawfly, however, producers are recommended to implement management strategies if 10 to 15 per cent of the stems were cut the previous year. With conditions conducive to successful over-wintering, a field with this level of damage could produce enough adults to increase cutting levels to 70 per cent or greater in the following year.

There are no insecticides registered for wheat stem sawfly and research trials have not shown any insecticides to be cost effective. Control measures are through agronomic and cultural practices. Some strategies are more practical and useful than others.

The most effective way to reduce damage from the wheat stem sawfly is through the incorporation of resistant cultivars and/or crops. Barley is not normally a host for the sawfly. Oats and broadleaf crops such as canola, flax and alfalfa are not susceptible to wheat stem sawfly. If wheat is to be grown as part of a current rotation, solid stem wheat varieties should be grown as they are considered to be more resistant to sawfly damage.

Select a resistant variety such as AC Eatonia or AC Abbey, and remember that a resistant variety will sustain damage in certain years or in certain environments. If seed source is an issue, spread out resistant variety as much as possible by seeding borders (trap cropping) of fields to the resistant variety. A new solid stemmed hard red spring wheat variety, AC Lillian, is expected to be available for the 2006 growing season.

Solid stemmed varieties are filled with pith, especially in the lower parts of the plant. This inhibits development and slows the movement of the larvae within the stem, resulting in increased larval mortality. One research study indicated that larval mortality was about 28 per cent in hollow

stems and about 67 per cent in solid stems. Although past reports suggested durum wheat varieties were rarely attacked, some durum varieties appear to be as susceptible as some spring wheat varieties.

Data collected at an Alberta site indicated that hollow-stemmed Canada Western Red Spring (CWRS), as a class, sustained 80 per cent damage compared to 53 per cent in 2000. The durum class, generally a better alternative to CWRS in terms of resistance to sawfly, went from 20 per cent in 2000 to more than 60 per cent damage in 2001. For example, cutting levels for AC Navigator increased from 13 per cent, in 2000, to 35 per cent, in 2001.

A solid-stemmed CWRS variety, AC Abbey, sustained 15 per cent cutting in 2001, compared to a two per cent cutting level in 2000. The hollow-stemmed variety, AC Barrie, experienced a 20 per cent increase in 2001, with over 90 per cent of stems cut.

The two years of data at this site shows how variable varietal resistance can be from year to year. Therefore, caution must be taken when extrapolating data from only one location or from a given year, as varietal resistance in one location on a given year may not be experienced elsewhere or in a successive year.

Stem strength and stand density may also be factors in affecting crop loss. In a thick crop, uninfested stems can support cut stems more effectively than can a thin stand. Agriculture and Agri-Food Canada researchers are currently investigating a number of aspects relating to wheat stem sawfly population dynamics and host plant phenology, as well as management options, including the use of trap crops, and blending resistant and susceptible cultivars together.

The Semiarid Prairie Agricultural Research Centre in Swift Current and the Lethbridge Research Centre, Agriculture and Agri-Food Canada (AAFC), maintain "sawfly nurseries" to evaluate wheat varieties for sawfly resistance. Lancer, Leader and newer varieties: AC Eatonia and AC Abbey are solid-stemmed and are considered to be resistant varieties. Producers requiring resistant varieties should check on availability of seed.

If damage in the previous year is confined to the field edges and has reached 10-15 per cent stems cut, resistant varieties could be seeded around the perimeter of the field as a "trap" or "barrier crop," with a high performing conventional variety in middle of the field. If damage extends across the field, the whole field should be seeded with a resistant or non-susceptible crop.

Other factors to consider if one is using resistant varieties alone or mixed (i.e. barrier or trap strips):

- Producers should consider potential loss as a result of sawfly feeding versus the loss from growing a lower yielding cultivar. Sawfly resistant varieties tend to be lower yielding or have lower protein than hollow-stemmed varieties. However, it should be noted that AC Abbey does have good yield and AC Eatonia does have good protein.
  An additional consideration for solid-stemmed varieties is that they tend to better withstand the drought conditions that often coincide with sawfly outbreaks.
- Pith formation in solid-stemmed varieties is depressed if the weather is cloudy during stem elongation. This factor partially accounts for variation in resistant varieties from year to year. Soil type may also influence the elongation of solid stems.
- If mixing varieties, the same wheat class should be used to prevent downgrading. Other traits should be similar between the varieties grown such as maturity and height in order to reduce variation when harvesting.

Other, but possibly less practical, management strategies include tillage, delayed planting and early swathing. However, each of these have specific agronomic costs.

If several stems split in late-July contain a larva (i.e.. four to six larvae per 10 stems split), consider swathing the crop. Early swathing, once kernel moisture drops below 40 per cent, can help to salvage infested stems before they fall and are more difficult to pick up. Even if a field is heavily infested, most wheat heads can be recovered if producers swath the crop early to create a more harvestable windrow. This requires judgment as swathing too early can result in low-test weights, reduced yields, and downgrading.

Conversely, a high percentage of stems could already be toppled over if the swathing operation is performed too late. If swathing is not economically or operationally feasible, combine the field as soon as grain moisture is low enough to bin the seed.

If sawflies are present, harvesting the perimeter of the crop as green feed may be an option, as this practice will likely destroy the larvae.

Tillage has been shown to have some effect in reducing sawfly populations. Shallow tillage in the fall has been shown to greatly increase larval mortality. Deep tillage will bury the infested stems and over-wintering larvae, but can result in other problems such as soil erosion. Spring tillage operations, however, do not appear to have as negative effects on the sawfly populations but do help reduce populations.

Generally it appears that less soil disturbance will result in more adult emergence. However, tillage operations can contribute to soil erosion and, therefore, producers should consider this option carefully, especially in lighter soil.

Delayed planting of wheat may be of some benefit to reduce sawfly damage, but yield and quality may also be affected. Late seeding can result in reduced yield and may expose the crop to early frost. This management strategy has been recommended only in cases where there is a high risk of wheat stem sawfly and a susceptible variety is being sown.

Although native grasses may act as hosts for the sawfly, actual outbreak situations do not appear to originate in these areas. Burning infested stubble has been considered as a possible strategy. This may help reduce larval numbers, but it is not recommended as a good agronomic practice and will also greatly reduce beneficial parasites. Burning or mowing of grassy field borders or ditches is also not recommended due to the severe impact on beneficial parasites residing in these areas.

Overall, the negative effects of burning far outweigh any benefits.

An integrated management approach using all of these management strategies will likely be necessary over a long term because it may take several years to bring populations of the wheat stem sawfly down to acceptable levels. Ideally, the strategy should be a community commitment since isolated attempts to manage sawfly populations will always be affected by populations in neighbouring fields.

May	**June**	**July**	**Aug.**	**Sept.**
Larvae Pupate	Adults emerge, mate and lay eggs	Egg-laying continues and larval feeding commences	larval feeding continues	Larvae over-winters

Natural Biological Control – Parasites

There are naturally occurring enemies of the wheat stem sawfly. The Braconid wasps, *Bracon cephi,* and a close relative, *Bracon lissogaster,* attack the larvae of the wheat stem sawfly resulting in significant reductions of sawfly populations. As the current-year sawfly larvae will survive and still consume plant matter, benefits of parasitism will not be realized until the following and subsequent years. It may take several years for the parasite populations to increase to effective levels.

Both parasites mentioned can have two generations annually. The first generation appears in June and July when adult sawflies are present. Eggs are laid on or near the sawfly larvae. The second generation of parasites appear about mid-August. However, sawfly larvae tend to be more protected within the plant stems at this time.

An extended growing season allows for longer availability of green wheat and grass stems and allows for a higher survival rate for the second generation of parasites. Conversely, if wheat ripens early, especially in consecutive years, there is a corresponding reduction in parasite populations.